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DISEASES OF THE ROSE IN ARIZONA

AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF ARIZONA, TUCSON

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KEY FOR IDENTIFICATION OF MALADIES OF ARIZONA ROSES

I. Plant dies suddenly (usually in hot weather), often within a week after first symptoms are noticed. **Root rots**

A. Tiny tan fungus strands on roots, or spore mats on ground (cottony white at first, becoming tan and powdery). **Texas root rot** (2)*

B. No signs of fungus. **Unidentified root rot** (6) or **too deep planting** (28)

C. New feeding roots absent or scant. **Weak plant** (29) or **too late planting** (26)

II. Plant stunted or yellowing, sometimes dies slowly:

A. Small knots or galls ⅛ to ½ inch on fibrous roots, small feeding roots usually scant. **Root-knot nematode** (1) (*E*)†

B. Large galls (½ inch to 6 inches), usually spherical, at crown of plant or on larger roots (occasionally on canes above ground). **Crown gall** (3) (*H*)

C. No galls on roots but root and top growth stunted. **Alkali, drought, low fertility,** or **weak plant** (26, 27, 29, 30, 31, 32, 33)

III. Definite lesions or dead areas on canes:

A. Canes die from tips. **Dieback** (7) (*I, K*)

B. Lesions beginning at pruning cuts or at crown. **Canker diseases** (11)

C. New succulent growth distorted and covered with a whitish powder. **Powdery mildew** (4) (*A, B*)

IV. Lesions, discolorations, or shedding of foliage:

A. Round, dark brown to black spots ⅛ to ⅜ inch diameter on leaves. **Black spot** (8) (*Q*)

B. Small irregular brown or black spots on older leaves in late summer. **Weather** (13)

C. Irregular darkened splotches on exposed surface of leaf in late summer. **Weather** (13) (*S*)

D. Powdery, whitish areas on leaves in spring, often causing curling and distortion. **Powdery mildew** (4) (*A, B*)

*Discussion of each disease appears in order of these reference numbers.
†Capital letters refer to illustrations.

E. Small, orange-yellow, powdery, pin-point lesions, usually more abundant on lower surface of leaf. **Rust** (9) (*C*)

F. Shedding of foliage. Usually due to severe form of **black spot** or **rust, drought,** or **other malady** (8, 9, 21)

G. Foliage pale green or yellowish.

a) Leaf blade light green, veins green. **Mild chlorosis** (5) (*Uc*)

b) Leaf blade and veins pale green to yellow. **Moderate chlorosis** (5) (*Ub*)

c) Leaf margins brown and dry, center pale yellow. **Severe chlorosis** (5) (*Ua*)

d) Leaf blade streaked or mottled with yellow, whitish, or pale green areas. **Virus diseases** (16) (*D*)

H. Tips or margins of young leaves dry and brown. **Hot, dry wind, drought, alkali, reflected heat** (33)

I. Tiny grayish green flecks on leaf. **Feeding of leafhoppers** (17) (*T*)

J. Bronzing and mottling of leaves. **Feeding of red spiders** (18)

K. Whitish spots on leaves or canes. **Scale insects** (19)

V. Lesions or discolorations of flowers:

A. Drying of margins of petals:

a) In hot weather. **Heat and wind** (20) (*O*)

b) In cooler weather. **Variety not adapted** (20, 29)

B. "Blueing"—change of color in some pink and red roses to an unpleasant purplish cast on exposure to light. **Variety not adapted** (21)

C. "Balling"—failure of petals to open properly:

a) Without browning of petals. **Variety not adapted** (22)

b) With browning of petals at base. **Thrips** (22) (*P*)

D. Flowers with stunted, thickened petals showing tiny blisters. **Severe chilling in early spring or late fall** (23) (*M*)

E. Young tips killed and blackened in early spring or late fall. **Frost** (24)

F. A brown, moist rot of petals in wet spring weather. **Soft rot** (25) (*N*)

VI. Leaf buds near ends of cane fail to open or open late. **Delayed foliation (34) (*J*)**

DISEASES OF THE ROSE IN ARIZONA

By R. B. Streets*

INTRODUCTION

The rose is deservedly popular in Arizona and elsewhere, both as an ornamental and for cut flowers. The climate of Arizona, especially the southern part, while in many respects favorable to the successful culture of roses, is in other respects unfavorable. The diseases and other factors causing poor growth in our state are correlated very closely with the type of climate we enjoy. Many of the most serious rose diseases, such as black spot, anthracnose, and cankers, have never been found in Arizona, and others serious elsewhere are not important here. There are, however, enough diseases which are obvious or important to call forth frequent requests for assistance. This publication should enable the rose grower to recognize the more prevalent diseases and apply control measures effectively. In case of doubt the grower may secure assistance by mailing to the Department of Plant Pathology, University of Arizona, Tucson, Arizona, freshly gathered samples showing if possible several stages of the malady, together with notes on conditions under which the plants are growing. The specimens should be loosely wrapped in waxed paper or slightly dampened newspaper and shipped at once after cutting.

Most of the inquiries about rose diseases come from the southern part of the state where the winters are mild and the summers hot, and the discussion centers around rose problems under those conditions. The information given, however, applies to the rest of the state, except that winter hardiness is a limiting factor at higher altitudes.

DISEASES OF MAJOR IMPORTANCE IN ARIZONA

1. ROOT-KNOT NEMATODE

A frequent and often unrecognized cause of poor growth in roses in the southern states is the root-knot nematode.

Symptoms

The above-ground symptoms—stunting, yellowing of foliage, and premature death—might be due to other causes, so it is necessary to examine the fibrous roots for the characteristic swellings or knots about ⅛ to ¼ inch in diameter and up to ½ inch or more in length (Pl. II *L*). In some infestations the roots become matted; in others, many roots decay and the fibrous roots are scarce.

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Enlarged lenticels (Pl. VI *V*) occurring on Odorata root have been confused with nematode galls.

Cause

The nematode is a slender microscopic round worm which forces its way into the tender root tips where it feeds, matures, and lays eggs. The eggs hatch and the young nematodes may live in the same root or emerge in search of other roots. Nematodes multiply very rapidly since there are as many as ten or twelve generations a year in warm climates. They are very difficult to eradicate, as they can survive in soil for months and the egg stage is resistant to drying and chemicals.

Control

There is no practical method of eliminating nematodes from infected roses. The hot water treatment recently advocated is still in the experimental stage and the temperature necessary to kill the nematodes in the root tissues also killed or greatly damaged the roots in many cases. The following methods are of value:

a) Examine the roots of bare-rooted roses before purchasing or planting and reject those showing root knot.

b) Destroy infected plants, because it is impossible to prune out all diseased roots.

c) Extra care and fertilizer are necessary, since infested plants suffer more in poor soils than in fertile ones.

d) Purchase roses on the "Texas Wax" rootstock (believed to be a strain of *Rosa odorata*) which is reported to be very resistant to nematodes in Florida soils.

e) In small areas, nematodes have been successfully killed in the soil by injections of chemicals such as formaldehyde (5%); carbon bisulphide (2 oz. per sq. ft.); or chloropicrin (2 to 5 cc. per cu. ft. of soil). Ask for special instructions for the application of these chemicals.

2. TEXAS ROOT ROT

Roses are frequently attacked by Texas root rot, which, next to root knot, is the most serious and widespread plant disease in southern Arizona. See *Extension Circular 103* for a full account of this disease.

Symptoms

Rosebushes which are apparently healthy and thriving and then die suddenly during the months of June to September, inclusive, may be suspected of having Texas root rot. While the attack comes apparently without warning, a close observer would have noted a yellowing of the foliage and a tendency of the leaves to wilt in midafternoon for some days before the final attack. If the dead plants are dug up and the roots carefully examined, the

presence of delicate strands of buff-colored fungus filaments on the surface of the roots (Pl. II) will establish the disease as Texas root rot. In case of doubt, it is advisable to refer the specimens to the Department of Plant Pathology for examination. During the summer months the fungus may appear on the surface of the ground as white mats of cottony filaments which within two or three days turn to buff-colored powdery spore masses (Pl. VI *Bottom*). These are found especially after rains or where the soil is moist after irrigations.

Cause

Texas root rot is caused by a fungus, *Phymatotrichum omnivorum,* which is native to the soils of the semiarid Southwest and becomes very destructive to plants grown under irrigation where conditions for its growth are very favorable.

Control

Root rot is a most difficult disease to control, as it persists in the soil for years and attacks most of the commonly cultivated trees, shrubs, and other ornamentals. In fact, the dangers of spread to any other susceptible plants in a city lot of ordinary size is so great that prompt and vigorous action should be taken to eradicate root rot before the whole planting becomes infected.

Since the disease does not become evident until it has destroyed so much of the root system that the plant dies from lack of water, very prompt action is necessary to save infected plants.

A soil treatment originated by the writer for treating root-rot-infected pecan trees has also proved successful in treating shade trees and other ornamentals. The soil of the infected area is first loosened to aid penetration and a dirt bank about 6 inches high built around it. The ammonium sulphate* is scattered evenly over the soil at the rate of 1 pound to 10 square feet. Then an equal amount of agricultural sulphur* is added to the same area and stirred into the loose surface soil until the yellow color disappears. The basin is filled with water to a depth of 3 inches and the ammonium sulphate is carried down into the root zone. This treatment can be used without injury to living plants, either healthy or diseased, *if directions are followed closely.* The dosage is very strong and plants may be defoliated or killed if too little water is used. From one-half to three-fourths of the top growth should be removed from infected plants. Generous use of well-rotted manure or other organic matter is advised for roses in areas where root rot is prevalent.

*Both materials are usually available from nurserymen and fertilizer dealers, but the use of nitrogenous fertilizers is restricted to food crops during the present war emergency.

3. CROWN GALL AND HAIRY ROOT

Crown gall is one of the common and serious diseases of the rose, gradually devitalizing the bushes and shortening their period of productivity and life.

Symptoms

Crown galls appear as roughly spherical, woody growths, usually on the rootstock below ground (Pl. II *H*) but occasionally on the canes above ground. They may occur at the point of grafting, on the side where buds have been removed, or at the base of the rootstock. Galls on the roots themselves are often the result of infection through cuts and other wounds made in digging and transplanting. Galls vary in size with age and the size and vigor of the roots attacked. Crown galls from the size of a cherry to that of a baseball are commonly seen, although both larger and smaller specimens are not rare.

In hairy root, which is much less common than crown gall, no definite galls are produced, but an excessive number of weak fibrous roots appears (Pl. II *G*).

Cause

Crown gall is caused by a bacterium, *Phytomonas tumefaciens;* hairy root by *Phytomonas rhizogenes.* Both organisms overwinter in the diseased tissues of infected plants, but they may survive in the soil for a year or more. New infections arise at points where cuts and injuries have occurred.

Control

(a) Diseased plants should be destroyed, as the removal of galls usually fails to check the disease. (b) Before replanting where roses have been lost from crown gall, remove the soil to a depth of at least 2 feet and replace with uninfected soil. (c) Infection takes place only through wounds, so care should be used in planting. Prune off damaged roots. (d) All new plants should have the roots inspected before planting; those having suspicious lumps or swellings should be rejected.

4. POWDERY MILDEW

Another widespread and often important disease of roses is powdery mildew. It can usually be found in rose gardens of any size in Arizona.

Symptoms

The powdery whitish or grayish growth on the young leaves, flower buds, and tender canes readily identifies the disease (Pl. I *A, B*). These powdery, whitish spots which are made up of chains of small colorless spores (the "seeds" of the fungus) appear on the foliage as soon as the leaves begin to develop in spring. Mildew spreads rapidly in warm, damp weather, but it usually is checked by hot, dry weather in June. In very susceptible roses

the powdery infection may spread over the leaves, young shoots, thorns, pedicels, and unopened buds, resulting in a drying and shedding of the foliage and unopened buds or the failure of buds to open properly. Plants are rarely killed by mildew, but their value as ornamentals is destroyed.

Cause

Powdery mildew is caused by a fungus, *Sphaerotheca pannosa* var. *rosae*, which hibernated as the common spore stage or as perennial mycelium, especially in association with the buds.

Varietal susceptibility

Nearly all types of roses are more or less susceptible, but in our climate many escape serious injury. The ramblers, Dorothy Perkins and Crimson Rambler, both climbing roses, are so badly injured by mildew and so bleached by our intense sunlight that they had better be discarded and replaced by some of the excellent climbers which are resistant to mildew. Also the control of mildew in the rose garden is much easier in the absence of very susceptible varieties.

Among the climbers relatively free from mildew are Climbing Cecile Brunner, Cl. Red Radiance, Cl. Golden Emblem, Cl. American Beauty, and Cl. Hoosier Beauty.

Control

(A) Dusting sulphur (300 to 325 mesh), applied when the first leaves unfold and repeated at intervals of ten to fourteen days, gives good control of mildew. Small hand dusters costing a dollar or less will apply the dust to the home garden in a few minutes. Special attention should be given to securing an even distribution of dust, and the application should not be heavy enough to show plainly. The fungicide kills the superficial fungus which has developed and protects against further infection as well.

(B) Liquid sprays are preferred by some and will also control mildew. The following are the most commonly used sprays:

a) Concentrated lime-sulphur, one part in fifty parts water.
b) Potassium sulphide (liver of sulphur), 1 ounce to 3 gallons of water, gives a spray which leaves no conspicuous residue.
c) Wettable sulphur sprays consist of finely ground (300 mesh) sulphur and a wetting agent such as glue, calcium caseinate, etc.

Caution

Do not use sulphur sprays where they will spatter on trellises or woodwork painted with *white lead* paint, as the spray will react with the lead oxide and form black lead sulphide stains. Paints made with zinc oxide will not discolor, as zinc sulphide is white. A drop of spray mixture on the painted surface will indicate whether or not your paint will discolor.

5. CHLOROSIS

Chlorosis, or lack of normal green color, is general and severe in roses as well as in many other woody plants in Arizona. While chlorotic foliage may be due to any of a number of causes, such as excess moisture, poor soil, alkali, or excessive amounts of fresh manure, the most common form encountered is due to lack of available iron, and this form is discussed below.

Symptoms

Three definite degrees of chlorosis are easily recognized, and if no steps are taken to correct the cause, plants may pass rapidly from one stage to the next.

a) *Mild chlorosis.*—The young leaves show normal green veins with paler green areas between (Pl. VI *Uc*).

b) *Moderate chlorosis.*—The young leaves lack normal green color; both the blade and veins are pale green to yellow (Pl. VI *Ub*).

c) *Severe chlorosis.*—Leaf blades are pale yellow with margins and tips brown and dry (Pl. VI *Ua*). Plants in this stage often die slowly. Chlorosis is most pronounced in the youngest leaves on the growing tips. The older leaves of plants recently affected may be a normal green.

Cause

The immediate cause of chlorosis is the lack of available iron necessary to the formation of the green chlorophyll in the leaves. The basic cause is the strongly alkaline nature of our soil solutions (water with dissolved minerals, etc.) which in the *p*H range between 7.5 and 9.0 renders the adequate supply of iron in our soils unavailable to plants by making it insoluble.

Control

Chlorosis may be treated in three different ways:

a) Supply soluble iron to the plant roots by making holes in moist soil in the root area from 3 to 9 inches deep and putting in each hole 1 heaping tablespoonful (about 1 ounce) of ferrous (iron) sulphate. Apply ½ to 1 pound per bush. Each irrigation will cause sufficient soluble iron to diffuse to adjacent portions of the root system to supply the plant. The same amount of iron salt broadcast over the soil is relatively ineffective as most of it is rapidly fixed in unavailable form. One treatment is usually effective for two to four years. Marked recovery usually occurs within a month after treatment.

b) Make soil conditions more favorable by application of agricultural sulphur and manure at the rate of 2 pounds of sulphur to a cubic foot of manure. Scatter the sulphur on the manure and mix it well with the surface soil. Improvement should be noted within one to two months. Application of iron sulphate in holes is also used to supplement this treatment.

c) Regulation of water is also necessary, as chlorosis is aggravated by excess water.

ROSE DISEASES NEEDING FURTHER INVESTIGATION

There are two diseases, or rather types of injury to roses, which are more or less prevalent and sometimes destructive in Arizona rose gardens. Concerning these we greatly need more definite information.

6. ROOT ROT

For lack of a better and more descriptive name, the most serious of these diseases is for the present called simply "root rot," as this describes the principal symptom, the sudden death of the root system followed by a drying of the top. Isolations made from the recently killed roots of such plants yield the usual variety of organisms recovered under such conditions, including several species of the fungus Fusarium. The disease has not yet been produced by inoculation with pure cultures of any of these organisms, so the cause is still unproved. The disease appears to be most severe from midsummer to late summer—a period of stress for the plant. Investigations are being continued to prove whether this is a single disease or a group of similar root rots with different causes, and to determine methods of control.

7. DIEBACK

The term dieback is used to designate the dying of the tips of twigs or branches of trees or shrubs, beginning at the tips and progressing toward the base. Dieback of the rose (Pl. III *I, K*) is not a specific disease due to one definite cause, but a symptom of impaired vigor due to one or more of the following conditions: deficiencies of plant food or water; excesses of plant food (for example, nitrogen) or soluble salts (alkali) or water; defoliation by black spot or rust; injury from canker diseases or root rots; infection by weakly parasitic fungi (such as *Diplodia* spp. or species of about eight other genera); winter injury; or in fact, any other agency which would lower the vitality of the plants.

Control

The first step in control would be to determine which of the above agencies is causing the dieback occurring under Arizona conditions and to apply appropriate control measures. Observations are in progress to determine what factors are primary in causing dieback in Arizona roses.

DISEASES RARE OR NOT KNOWN TO OCCUR IN ARIZONA

The following rose diseases, although not at this time of common occurrence or importance in Arizona, are briefly discussed on account of their prominence in rose literature and to assist

Arizona rose growers to recognize and if possible eradicate them if they should appear in the state.

8. BLACK SPOT

While black spot is the disease listed first in the order of usual prevalence and importance wherever the rose is grown, no authentic record of its occurrence in Arizona is known to the writer. Inquiries among experienced rose growers have failed to produce evidence of its occurrence in the state.

Symptoms

Black spot is principally a disease of the leaves, although it may also occur on the leaf petioles, flower peduncles, or on the canes. The spots on the leaves are black, nearly circular (Pl. V *Q*), and can be distinguished from other leaf spots by a darker and more uniform color and a fringed margin which is evident only upon close observation. The spots are from 1/16 to ½ inch in diameter and frequently run together, producing irregularly shaped lesions of large size. Often the zone around the lesions or the entire leaf turns yellow and may be shed prematurely. When black spot is severe the plants may be partially or almost completely defoliated during the growing season. Cane lesions occur as dark, raised, irregular blotches on tender, immature wood.

Following early season defoliation, leaf buds which should remain dormant until the following year may open late in the season. This results in improperly matured wood and weakened plants subject to other diseases and injuries.

Cause and life history

Black spot is caused by a fungus (*Diplocarpon rosae*) which overwinters either in leaves remaining on the bushes, in cane lesions, or in infected rose leaves on the ground. The distribution of black-spot spores is dependent on high humidity and moisture on the leaves from rain or sprinkling with a hose. Penetration of the leaf is rapid, requiring only eight to twelve hours under favorable conditions, and the lesions may become visible in about a week. The new lesions soon produce spores, and the cycle is repeated as long as the weather is favorable. The absence of black spot from Arizona rose gardens is apparently due to prevailing low humidities and long intervals (often three or four months or more) between rains.

Control

(a) Collect and burn all infected leaves, stripping leaves from plants and raking ground in dormant season. (b) Dust plants lightly once a week with dusting sulphur, beginning when first new shoots appear. Discontinue dusting or reduce to once every two or three weeks during hot, dry weather, as too heavy or too frequent use of sulphur will cause burning of the foliage. (c)

Select varieties such as Radiance, Etiole de Hollande, Edith Nellie Perkins, and Lady Hillingdon, which are least affected by black spot.

9. RUST

Although a serious disease in England and widespread and sometimes destructive on our Pacific Coast from San Diego to Vancouver, British Columbia, rust is rare indeed on garden roses in this state.

Symptoms

A yellowing of the leaves followed by premature defoliation is the most conspicuous symptom of rose rust. The disease is also easily recognized by small orange spore masses which usually occur on the under surface of the leaves in early summer. These spore masses form on yellow-orange spots visible from either side of the leaf (Pl. I *C*). Similar lesions may occur on the canes. In late summer and autumn very tiny black spore masses are produced on the infected leaves.

Cause

The rust fungi are often highly specialized in regard to the species and varieties of host plant they can attack, and the nine species of Phragmidium which attack roses appear to follow this pattern. One authority believes that the species occurring on "cultivated roses having large leaflets," which includes our hybrid teas, is *Phragmidium disciflorum*. Rose rusts are common on the native species of roses throughout the United States (including the mountains of Arizona), but the wild-rose rusts apparently do not spread to the cultivated roses.

Control

If rust appears: (a) When the plants are dormant or semi-dormant, strip them of infected leaves and rake and burn fallen leaves. (b) As soon as growth starts, apply dusting sulphur or a sulphur spray at weekly intervals until hot, dry weather begins. Infection takes place through the under surface of the leaves, so use special care to cover them thoroughly.

10. ANTHRACNOSE

Anthracnose, caused by the fungus *Sphaceloma rosarum*, is of wide distribution but has not yet been found in Arizona. It is often confused with black spot or other leaf-spot diseases. Rose anthracnose affects all aerial parts of the plant, but it is most conspicuous as a leaf spot. The mature lesions have an ash-gray center with spore-bearing bodies and a dark brown definite margin often surrounded by areas of yellow, red, or brown (Pl. V *R*). The control is the same as that for black spot.

11. CANKER DISEASES

There are at least four fungi which produce canker diseases of the rose. While each of these cankers is more or less common in certain parts of the United States and under certain conditions causes considerable damage, they are apparently of minor importance in Arizona. They are similar in appearance, method of infection, and control, so they can be considered together.

Symptoms

Cankers are lesions starting usually from the cut end left by pruning or cutting flowers, or developing at an injury near the base of the plant (Pl. III *L*). They gradually enlarge, often becoming several inches in length. Cankers at the base of the plant usually girdle the infected cane, which dies. Older cankers bear the tiny fruiting bodies of the fungi which cause them and furnish spores which spread the infection. The rose cankers in approximate order of their prevalence and importance are:

a) Brown canker (*Diaporthe umbrina*) forms dark brown cankers which may have a purplish margin. It may also attack leaves and blossoms.

b) Stem and graft canker (*Coniothyrium fuckelii*). The lesions appear as small pale yellow or reddish spots enlarging to form dry, wrinkled, or cracked cankers bearing numerous minute black spore bodies.

c) Brand canker (*Coniothyrium wernsdorffiae*) was prevalent and severe in a northern state where climbing roses were laid down and covered with soil to prevent winter injury. When the soil covering was omitted the disease disappeared.

d) Crown canker (*Cylindrocladium scoparium*) attacks the base of the canes and is principally a greenhouse disease.

Control of cankers

Since infection occurs principally through wounds made in pruning or cutting flowers (although any other injuries, such as the breaking of thorns from the cane, can result in infection), special care should be taken to make the cuts properly. In fact, the most effective prevention of canker diseases has been obtained by using sharp pruning shears which will not bruise the cane, making each cut ¼ inch above a bud, slanting the cut away from the bud. These short stubs rarely become infected. In removing side branches, cut as close as possible to avoid leaving a stub. Cuts over ¼ inch in diameter may be better protected by applying a fungicide or wound dressing, such as tree paint or orange shellac.

12. LEAF SPOTS

A number of leaf spots and other minor diseases are omitted, as they are not known to occur in the state and their inclusion might lead to confusion.

FOLIAGE DEFECTS

13. SHEDDING OF FOLIAGE

The two most frequent causes of midsummer shedding of foliage (black spot and rose rust) are no problem in Arizona, but shedding can be caused by drought or other unfavorable condition. Many books and articles on rose culture recommend a summer period of rest and dormancy achieved by withholding water, but these instructions cannot safely be followed in southern Arizona. In spite of its thorns the rose is not a cactus and will not thrive if obliged to go without water for long periods. A light irrigation every ten to fourteen days is a minimum for the summer rest period—or for the winter dormant period, for that matter.

14. DISCOLORED FOLIAGE

Beginning in late spring and increasing in severity through summer and fall, rose foliage in southern Arizona shows several types of injury from heat and dry air. The spots are often confused with black spot or other diseases, so it is desirable that their true nature be recognized.

The most common types of injury seen are (a) small irregular brown or black spots and (b) irregular darkened splotches on the exposed surface of the leaf (Pl. V *S*). These appear on the older leaves in late summer and are more prevalent on plants in poor soil, in very hot locations, and with irregular water supply.

15. DRYING OF TIPS AND MARGINS

The tips and margins of young leaves not yet fully matured may become dry and brown from exposure to dry, hot wind, drought, alkali, or reflected heat.

16. VIRUS DISEASES

There are four recognized virus diseases of the rose, but only one has been found in Arizona, and this on a few plants recently imported from another state. The leaf blades are streaked or mottled with yellow, whitish, or pale green areas (Pl. I *D*), and the plants are stunted and unproductive. All plants with virus infection should be promptly destroyed because they cannot be cured and the disease is readily spread by small sucking insects (leafhoppers, aphids, etc.).

The following three *maladies* are *often confused with plant diseases* and are listed here on that account.

17. Tiny, grayish green flecks on the leaflets are due to the feeding of leafhoppers (Pl. V *T*).

18. Bronzing and tiny mottled patterns on leaves are due to the feeding of red spiders.

19. Small oblong, whitish spots on leaves or canes are wingless sucking parasites called scale insects.

The Department of Entomology can furnish control measures.

BLOSSOM BLIGHTS

20. DRYING OF PETALS

In hot weather the drying of the margins of petals (Pl. IV *O*) is so common an occurrence in nearly all varieties that it limits the value of the midsummer bloom. It is least prevalent under the best growing conditions—deep, rich soil and adequate, well-regulated irrigation. For cut flowers, drying can be avoided by cutting the roses as buds very early in the morning (at least by 8 o'clock) and allowing them to open indoors. Lack of soil moisture is a common cause of drying of the petals. Watch soil moisture carefully during the spring bloom!

Some roses with thin, delicate petals show more or less drying, even in the comparatively cool spring and fall blooming seasons. These varieties are not adapted to our climate and should be discarded.

21. "BLUEING"

The petals of some pink and red roses change color to an unpleasant purplish hue on exposure to our intense sunlight. Varieties showing a marked tendency to blueing are not adapted and should be discarded.

22. "BALLING"

Failure of the petals of the bud to open properly is called "balling," and such blossoms are worthless. If balling occurs without a browning of the petals at the base, the variety is not adapted and should be discarded. If the base of the petals is browned or tiny brown spots appear on the petals (very conspicuous on light-colored varieties) the balling is caused by tiny slender insects called thrips. The Department of Entomology will furnish directions for control.

23. DEFORMED BUDS

In early spring or late fall certain buds may show stunted and thickened petals bearing tiny blisters, and these buds often fail to open normally (Pl. IV *M*). This condition is due to severe chilling (just short of freezing). Certain varieties very sensitive to thrips injury may develop deformed buds or flowers when the attack is severe (Pl. IV *P*).

24. FROST

While rosebushes and climbers are usually only semidormant during the coldest weather in southern Arizona, they seldom show winter injury. An occasional spring frost catches the tender growth and the buds and tips of canes are killed and blackened, but growth is promptly resumed and no treatment is necessary. Tea roses are more tender than the common hybrid teas and should be planted in more protected locations.

25. SOFT ROT

A brown, moist rot of petals (Pl. IV *N*) is sometimes encountered during wet spring weather. This is due to a bacterial invasion of the tender petals which causes a soft rot, but it usually disappears as soon as our normal dry, sunny weather returns.

OTHER CAUSES OF FAILURE WITH ROSES

The following causes of failure with roses are listed more or less in the order of their importance and the frequency with which they are encountered.

26. LATE PLANTING

For most purposes January is the best month for planting *bare-rooted* roses in southern Arizona, although the favorable season extends from December 15 to February 15. Prevailing temperatures following late planting stimulate top growth at the expense of root growth. This often results fatally about midsummer. Bare-rooted roses should be planted before the buds break and top growth begins.

After February 15 it is advisable to plant roses which have been started in cans. The better nurseries now plant all unsold roses in cans at an earlier date than formerly, and with better care they now produce roses satisfactory for late spring planting. Care must be taken not to break the ball of soil and injure the roots while removing the can.

27. POOR SOIL CONDITIONS

Most Arizona soils are too alkaline and too deficient in humus for the best results with roses. Both conditions can be improved by spading in well-rotted manure or other organic matter to which has been added 1 pound of agricultural sulphur per cubic foot of manure.

Our heavy (clay or adobe) soils may have poor drainage and poor aeration, while the lighter soils are often underlaid with caliche or hardpan, which may likewise cause poor drainage. Rose roots will die in soil that is constantly too wet.

Nitrogen is the fertilizer element most often deficient in Arizona soils, and additions of manure and commercial fertilizers like ammonium sulphate, calcium nitrate, or sodium nitrate will stimulate growth in all except perhaps our richest agricultural soils. One pound to 25 square feet of bed applied in January or February followed by a generous irrigation should be sufficient for one year.

28. TOO DEEP PLANTING

Care should be taken in planting that the point of budding or grafting (marked by a definite swelling and angle in the stem) be covered not more than 1 or 2 inches. Deeper setting appears to be

unfavorable under conditions here, and many plants set with the bud union 3 to 6 inches below the surface have died.

29. VARIETY NOT ADAPTED

Many varieties which are gorgeous in the cool, moist climate of the Pacific Coast are not adapted to southern Arizona's hot, dry climate. Conversely, some of the varieties most successful here are of little value on the Coast.

The following varieties of roses have been selected on the basis of disease resistance, general vigor, and adaptability to the climate of southern Arizona on the basis of the writer's observations and experience as an amateur rose grower during the past seven-

BUSH ROSES	CLIMBING ROSES
Red	**Red**
*Hadley—early	*Cl. Hadley—early
*Hoosier Beauty	*Cl. Hoosier Beauty
Etiole de Hollande	Cl. Etoile de Hollande
†Red Radiance	†Cl. Red Radiance
Ragged Robin—for hedges	Paul's Scarlet—decorative
Pink	**Pink**
*Los Angeles	Cl. Los Angeles
†Rose Marie	†Cl. Rose Marie—everbloomer
Imperial Potentate	Belle of Portugal—very early, blush pink, vigorous
†Pink Radiance	Mme. G. Staechlin—ruffled petals
*Briarcliff	American Pillar—single, vigorous
*Dainty Bess—single	Cl. Dainty Bess—single
Pink-yellow blends	**Pink-yellow blends**
Mme. Edw. Herriott—decorative	Cl. Mme. Edw. Herriott—decorative
†Talisman	*Cl. Talisman
*Herbert Hoover	Cl. Herbert Hoover
Yellow shades	**Yellow shades**
*Mrs. E. P. Thom—yellow	Cl. Mrs. E. P. Thom—yellow
Golden Emblem—deep yellow	Cl. Golden Emblem—deep yellow
†Joanna Hill—apricot	Cl. Sunburst—apricot
Angele Pernet—burnt orange	Yellow Banksia—apricot
*Sunburst—apricot	
White	**White**
*Frau Karl Druschki	Cl. Frau Karl Druschki
Caledonia	Silver Moon—semidouble
	White Banksia
Polyantha (baby roses)	**Polyantha**
*Cecile Brunner	*Cl. Cecile Brunner
Floribunda (cluster roses)	
†Ellen Poulsen—pink	
†Else Poulsen—pink	
†Kirsten Poulsen—pink	
†World's Fair—dark red	
†Holstein—red	

*Some fall bloom.
†Good fall bloom.

teen years. The list does not attempt to include all the "best" roses but suggests representative varieties of each color that have proved generally satisfactory. Many promising new varieties and patented roses are omitted, as the number available for observation does not warrant a definite rating at this time.

If a rose does not produce satisfactory growth within two years under good cultural conditions, it is a poor variety, a poor bush of a good variety, or diseased. *Pull it out!*

30. ROOTSTOCK NOT ADAPTED

At least four different rootstocks are used commercially for roses, and no definite information is available concerning which is the most satisfactory for southern Arizona. Ragged Robin is the stock most generally used and is usually considered the best rootstock. Odorata shows promise, but not enough bushes have been grown on this stock to establish its value. Failures may be due to rootstocks not adapted to Arizona soils and climate (Pl. II *F*).

31. TOO HEAVY PRUNING

Cutting back the bushes to two or three canes 6 inches high, as frequently advocated, often results in short-lived bushes in this climate. Here better growth and more flowers are secured by moderate pruning, which develops a much larger bush that shades the ground and shows less injury from heat.

32. ROOT COMPETITION

The growth of roses is often stunted by too much competition with the roots of trees, shrubs, and Bermuda grass. One exception might be noted. Roses, especially the more vigorous varieties of climbers, planted in new gardens *at the same time* as the competing trees, shrubs, and grass, often thrive; but attempts to establish them in older plantings in soil already filled with roots are less successful.

33. EXCESS HEAT

Too high soil and air temperatures retard both bloom and vegetative growth. Climbers will thrive on an east or north wall, but will show the effect of direct and reflected heat on a south or west exposure unless they are on a trellis a foot or more from the wall. High soil temperatures may be combatted and moisture conserved by a 2-inch mulch of peat moss, manure, or other organic matter around the plants.

34. DELAYED FOLIATION

Following unusually warm winters in the warmer parts of Arizona, some varieties show bare tips of the previous year's canes, or parts of canes on which the buds fail to develop (Pl. III *J*). This is due to lack of sufficient chilling to induce normal growth. The affected canes may be pruned out.

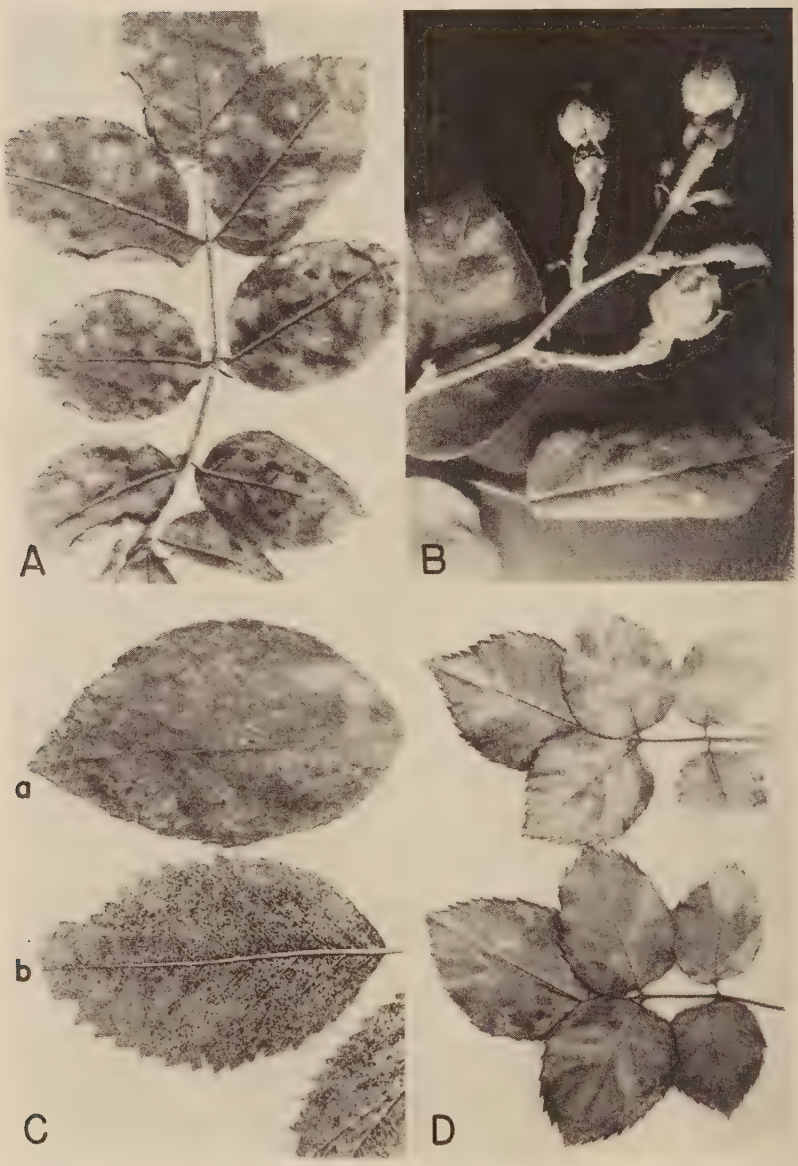

Plate I.—Foliage diseases: *A*, powdery mildew on young rose leaf; *B*, pedicels and rosebuds blighted by powdery mildew; *C*, rose rust on leaflets—(*a*) orange summer spore stage and (*b*) dark brown winter spore stage; *D*, mottled leaves resulting from infection by rose virus 1.

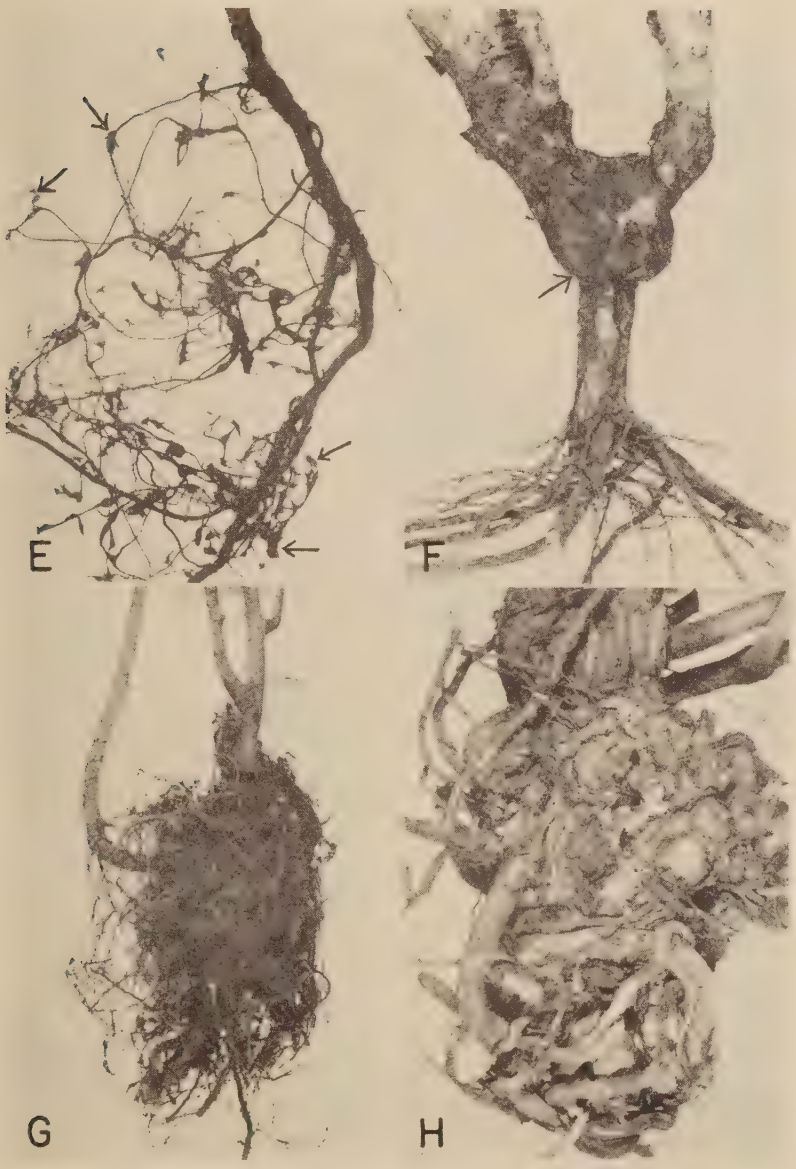

Plate II.—Root and crown diseases: *E*, small spindle-shaped or irregular galls on feeding root of rose. The galls are caused by the root-knot nematode. *F*, incompatability of rootstock and scion showing marked on-growth of scion. Plant was slowly dying without evidence of definite disease. *G*, hairy root, a disease similar to crown gall; *H*, crown of an old climbing rose, showing numerous crown galls. (Shipments represented by specimens *E* and *G* were denied admission to the state by the quarantine inspector.)

Plate III.—Cane diseases: *I*, Dieback of young cane; *J*, delayed defoliation affects certain varieties following abnormally warm winters; *K*, dieback of older cane; *L*, rose canker showing fruiting bodies of the fungus.

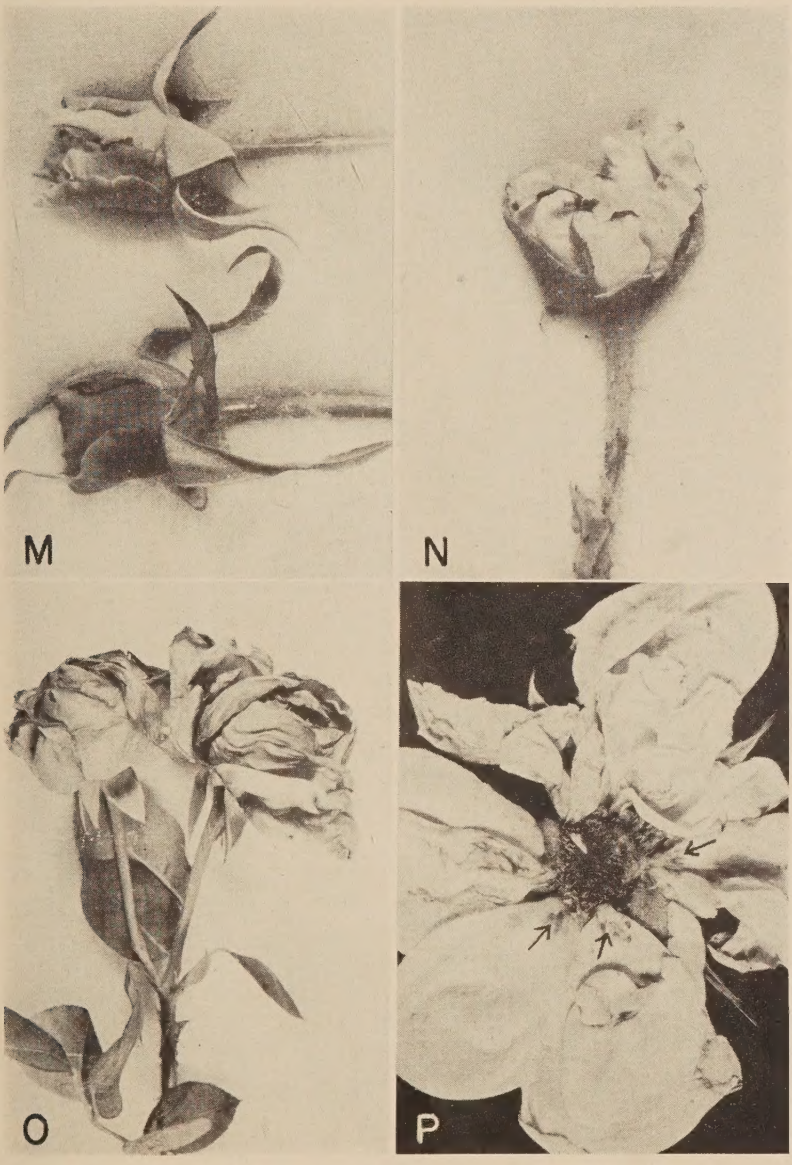

Plate IV.—Flower blemishes: *M*, "bull heads" or stunted abnormal buds resulting from cold injury in early spring or late fall; *N*, margins of petals at first water soaked then dry and brittle following rain or excess moisture; *O*, drying of petals exposed to hot, dry air in late spring and summer; *P*, thrips damage to rose petals. Note small brown areas near base of petals and shedding of petals.

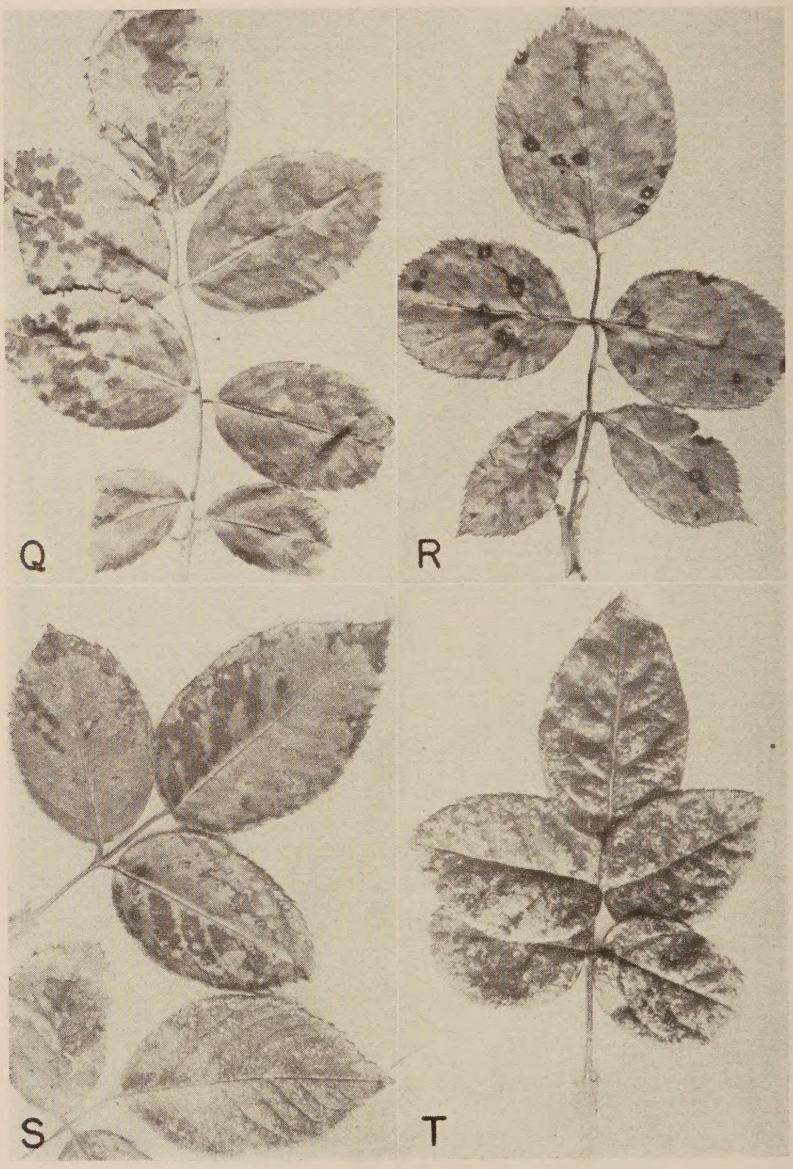

Plate V.—Leaf diseases and blemishes: *Q*, black spot, a fungus disease dependent on moisture, therefore rare in southern Arizona; *R*, anthracnose, another serious disease not yet found in Arizona; *S*, rusty brown or black irregular spots and splotches often found on old leaves as a result of weathering, especially heat and dryness; *T*, white flecking of rose leaves in early spring as result of feeding of grape leafhopper.

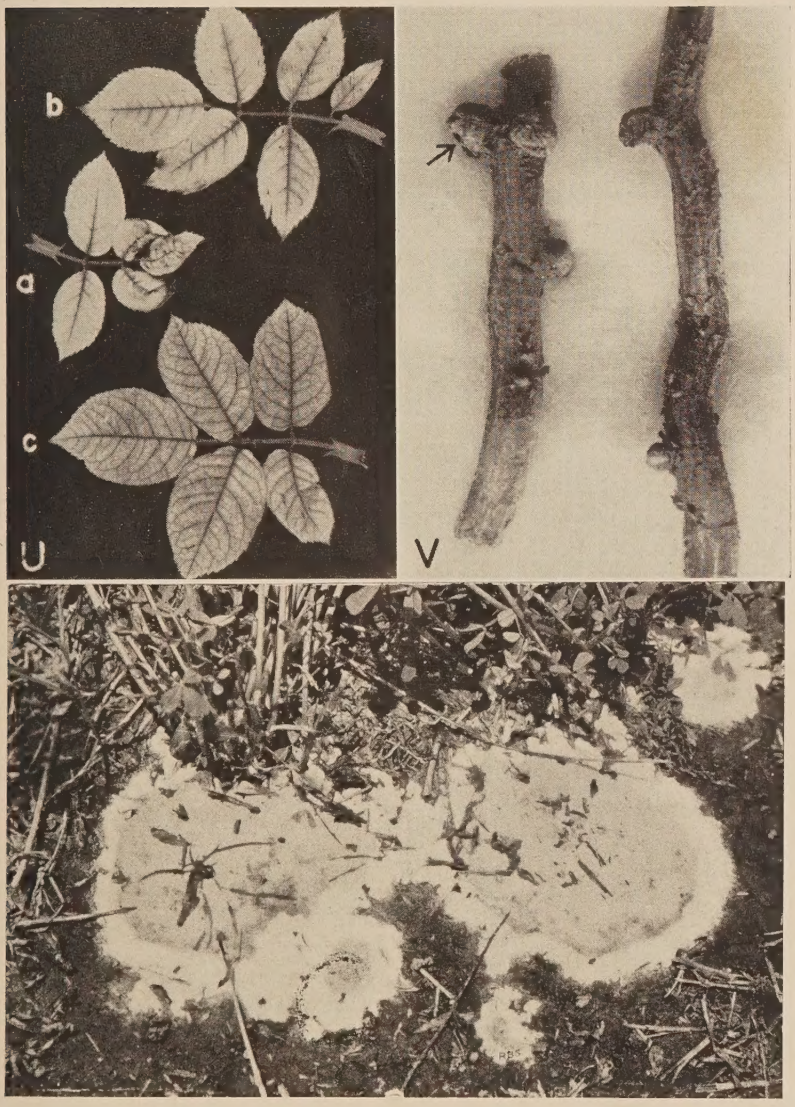

Plate VI.—*U*, lime-induced chlorosis, a very common malady in Arizona: (*a*) severe chlorosis, with stunting and drying of leaflets (*b*) moderate chlorosis, with only main veins retaining green color and (*c*) mild chlorosis, with green color retained in all veins. *V*, Enlarged lenticels on feeding roots of roses budded on Odorata root. Has been confused with root-knot infestation (x3). *Bottom*, spore mats of the root-rot fungus.